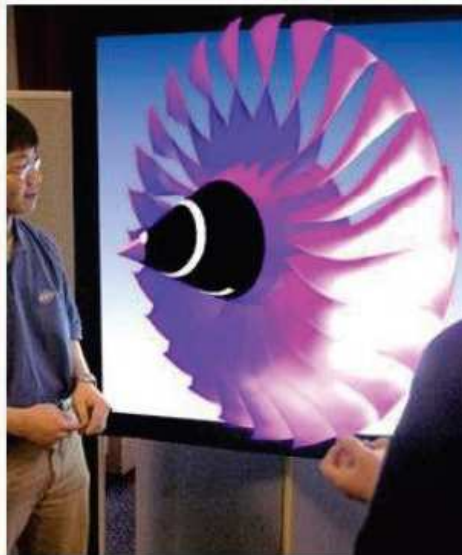
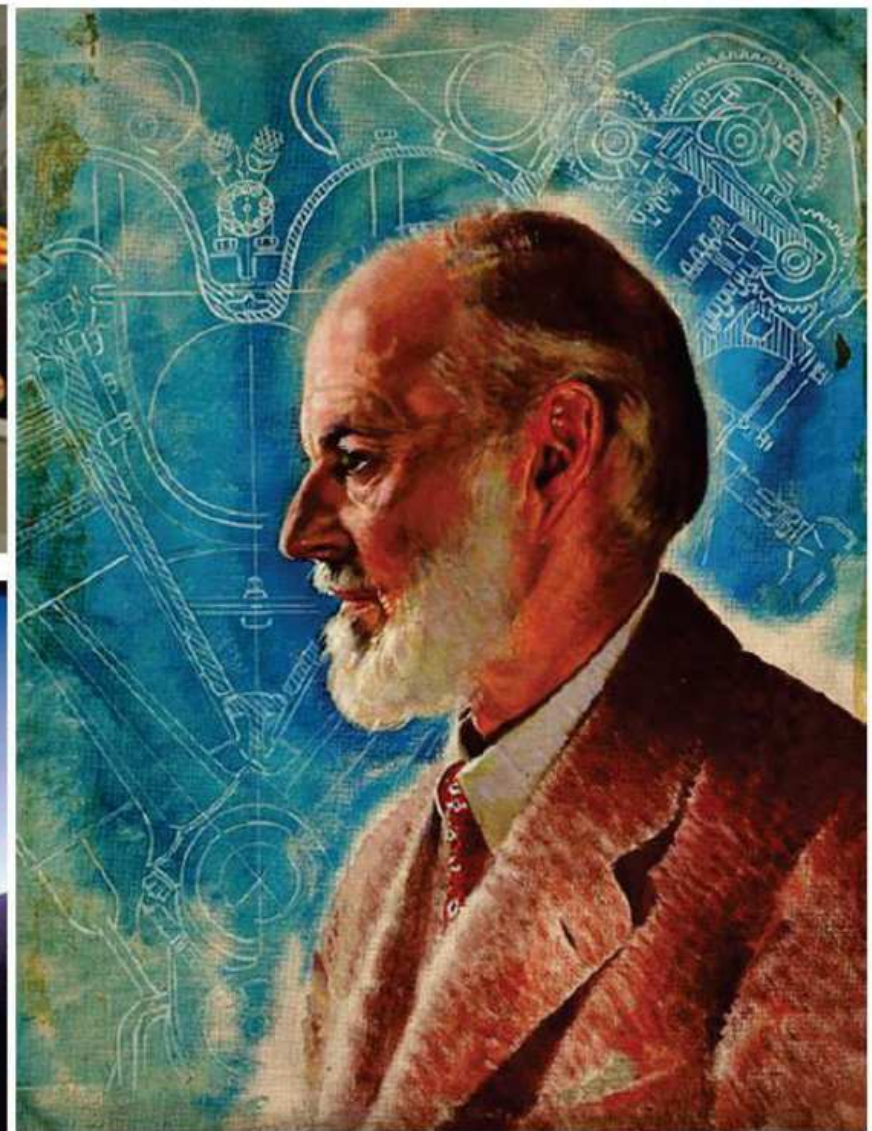
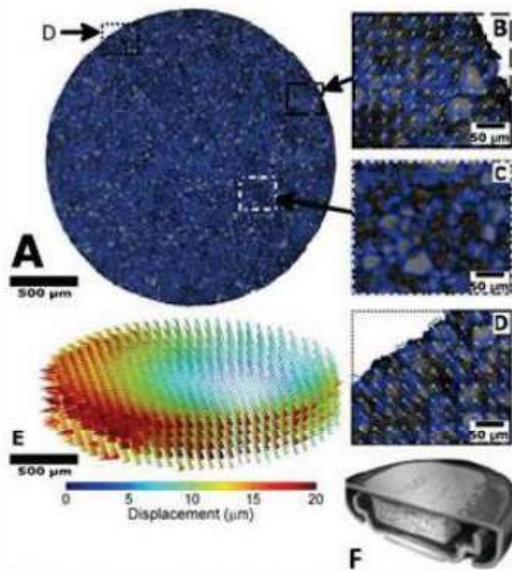
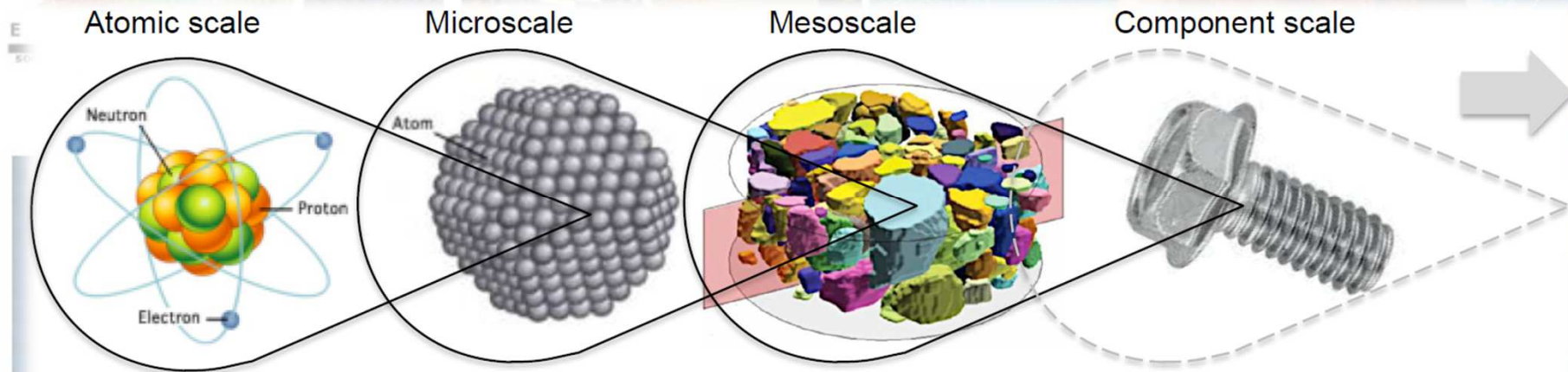


The Sir Henry Royce Institute for Advanced Materials



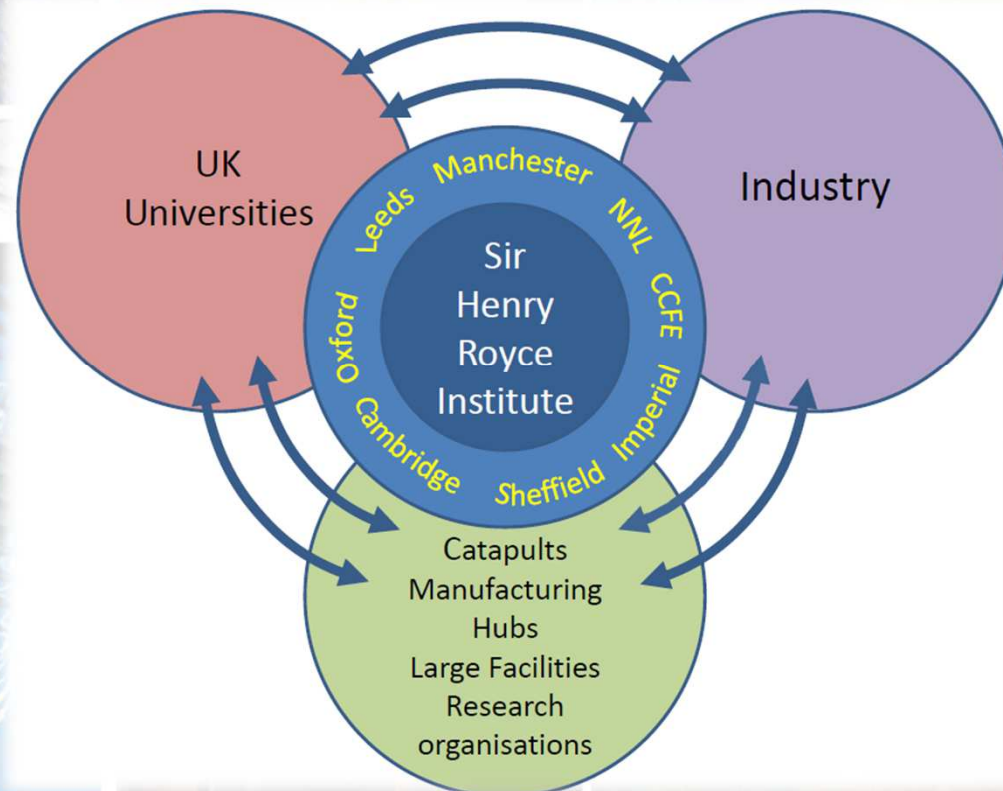
The Sir Henry Royce Institute for Advanced Materials

Aim = design from the 'atom to the component'; fabricate, test and analyse advanced materials, and their application, feeding into the wide range of manufacturing sectors



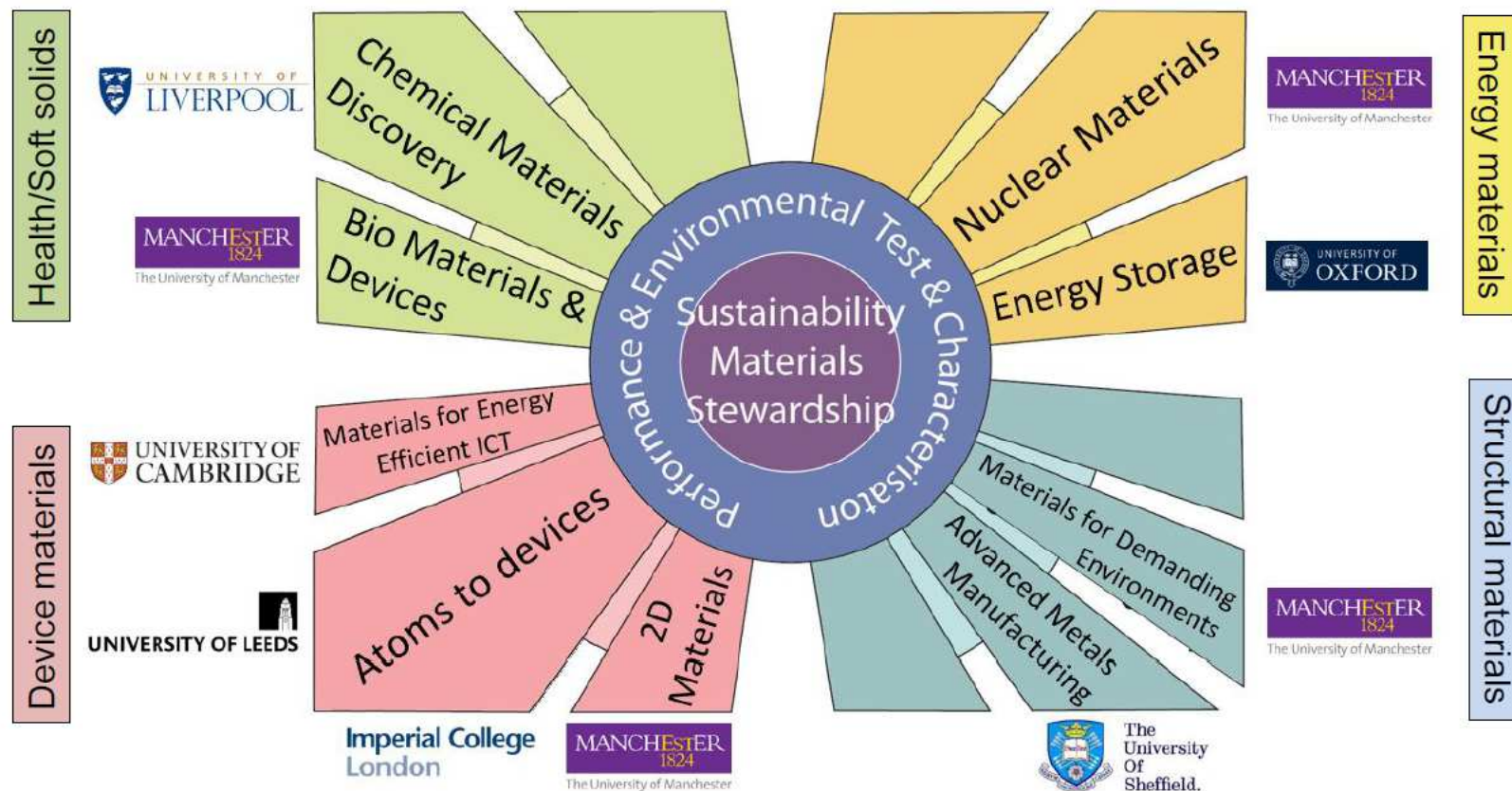
The Sir Henry Royce Institute for Advanced Materials

Vision = An international flagship for the accelerated discovery and development of new materials systems for economic and societal benefit



SHRI: capability outline

- 4 overarching Materials Theme Areas: **Structural | Energy | Device | Soft & Health**.
 - each with a number of Core Capability areas
- Hub: Modelling, Testing, Imaging & Characterisation, Sustainability & Management
- Focus will be on research at TRL 1-5

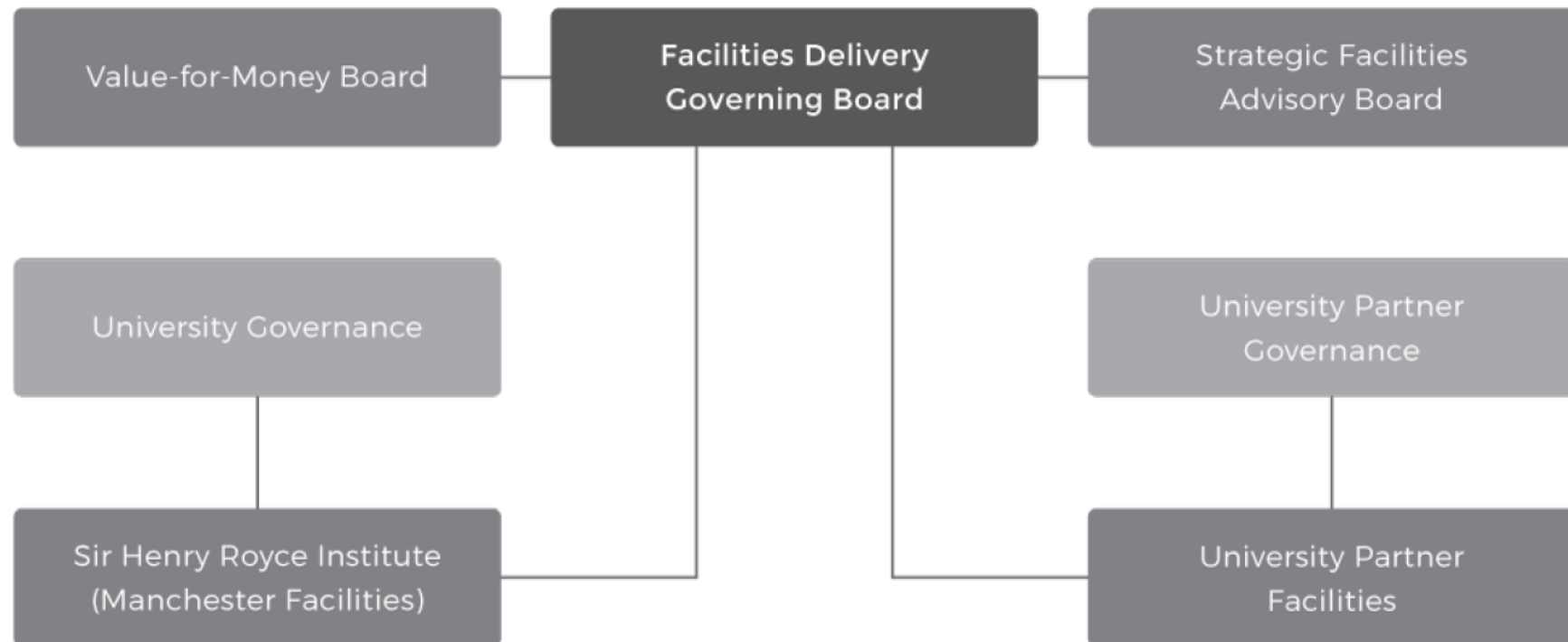


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<u>Core Area</u>	<u>Institution</u>	<u>Academic lead</u>
Biomedical materials & Devices	Manchester	Prof. Paulo Bartolo
Nuclear materials	Manchester	Prof. Melissa Denecke
Materials for Demanding Environments	Manchester	Prof. Michael Preuss
2D & Nanomaterials	Manchester	Prof. Vladimir Falko
Chemical materials discovery	Liverpool	Prof. Andrew Cooper FRS
Atoms to Devices	Leeds	Prof. Edmund Linfield
Atoms to Devices	Imperial College London	Prof. Neil Alford MBE
Adv. Metals Processing	Sheffield	Prof. Mark Rainforth
Energy Storage	Oxford	Prof. Peter Bruce FRS
Materials for Energy Efficient ICT	Cambridge	Prof. Sir Richard Friend FRS

Sir Henry Royce Institute: governance



As a National Institute the Royce is subject to independent scrutiny and governance.

Chair of the Governing Board: Baroness Brown of Cambridge, Professor Dame Julia King DBE, FREng

Interim Chief Science Director: Regius Professor Philip Withers FRS

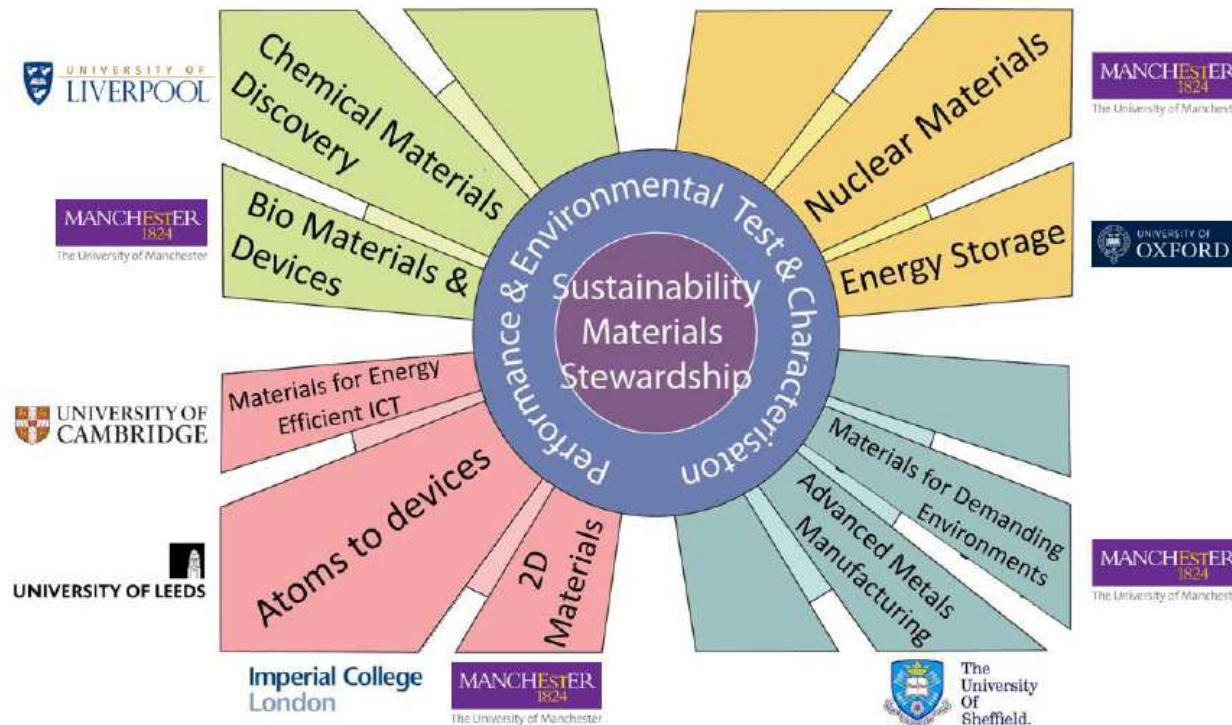
Membership of the Strategic Facilities Advisory Board

Industrial/ Research Organisations	Independent academic
Rob Hardeman, Seagate Technology	Mark Smith, University of Lancaster (Chair)
Ann Kramer, The Electrospinning Co.	Helen Atkinson, University of Leicester
Phill Cartwright, HVM Catapult	Julie Yeomans, University of Surrey
Mick Steeper, Primetals Technologies	Richard Catlow, University College London
Henri Winand, Intelligent Energy	
Neil Thomson, EDF Energy	



The University of Manchester

Emerging nuclear capability



**Advanced
Materials for
Nuclear Energy
Core Area of *The
Sir Henry Royce
Institute***

£235m capital and £48.4m revenue

£150m capital for a £200m Hub facility at The University of Manchester (UoM)

£85m capital for facilities at founding partners

£132m with total revenue costs for 6 years (2016-2022)

SHRI Nuclear Materials Partners

- Manchester – (lead) Materials for future fuels lifecycle
- NNL – testing and characterisation of rad materials
- Oxford – modelling materials for fusion&fission; manufacture and characterisation
- Imperial – engineering alloys, structural ceramics, MAX, ZrC, waste forms
- Culham – Sample dimension reduction & characterisation
- Sheffield – backend & (in-core) structural materials

Advanced Materials for Nuclear Energy

Vision: Forward looking advanced materials R&D for nuclear fuel / fuel cycle and in-core structural materials for fission and fusion energy, targeting optimising performance for safety and maximising economies.

Materials for Fuel & Fuel Life Cycle

Fuel production and performance
Energy & materials co-production
Waste conditioning & disposal

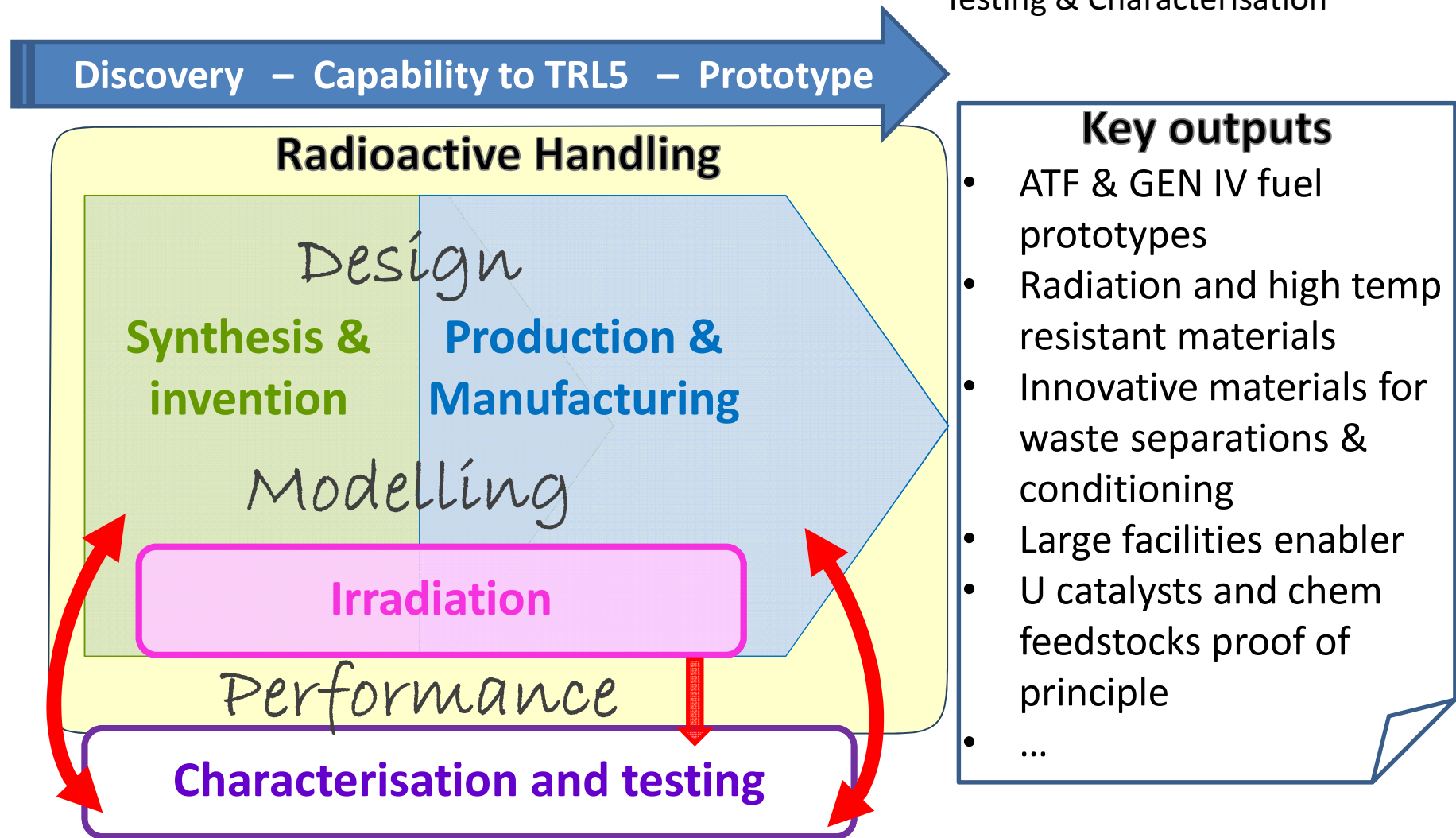
Structural Materials for Fission & Fusion

Self-healing coatings
Novel nuclear structural materials
Link mechanical properties and irradiation effects in engineered alloys

- ✓ TRL 1-5 with trajectory to higher TRLs at NFCE, NNL and industry
- ✓ Joined up with NIRAB recommendations plus added value of revenue from waste
- ✓ Exploit synergies between institutions for unique/integrated capability
- ✓ Nurturing young talent for tomorrow's UK nuclear leaders
- ✓ Extension of existing nuclear expertise in the Northwest

4 suites of infrastructure

Synthesis & Invention,
Production & Manufacturing,
Irradiation & Radioactive Handling,
Testing & Characterisation



Universities of Manchester, Oxford, Sheffield, Imperial , and UKAEA and NNL

Royce: Nuclear R&D Partnership

TRL levels



Activity levels



Partners



Key Messages

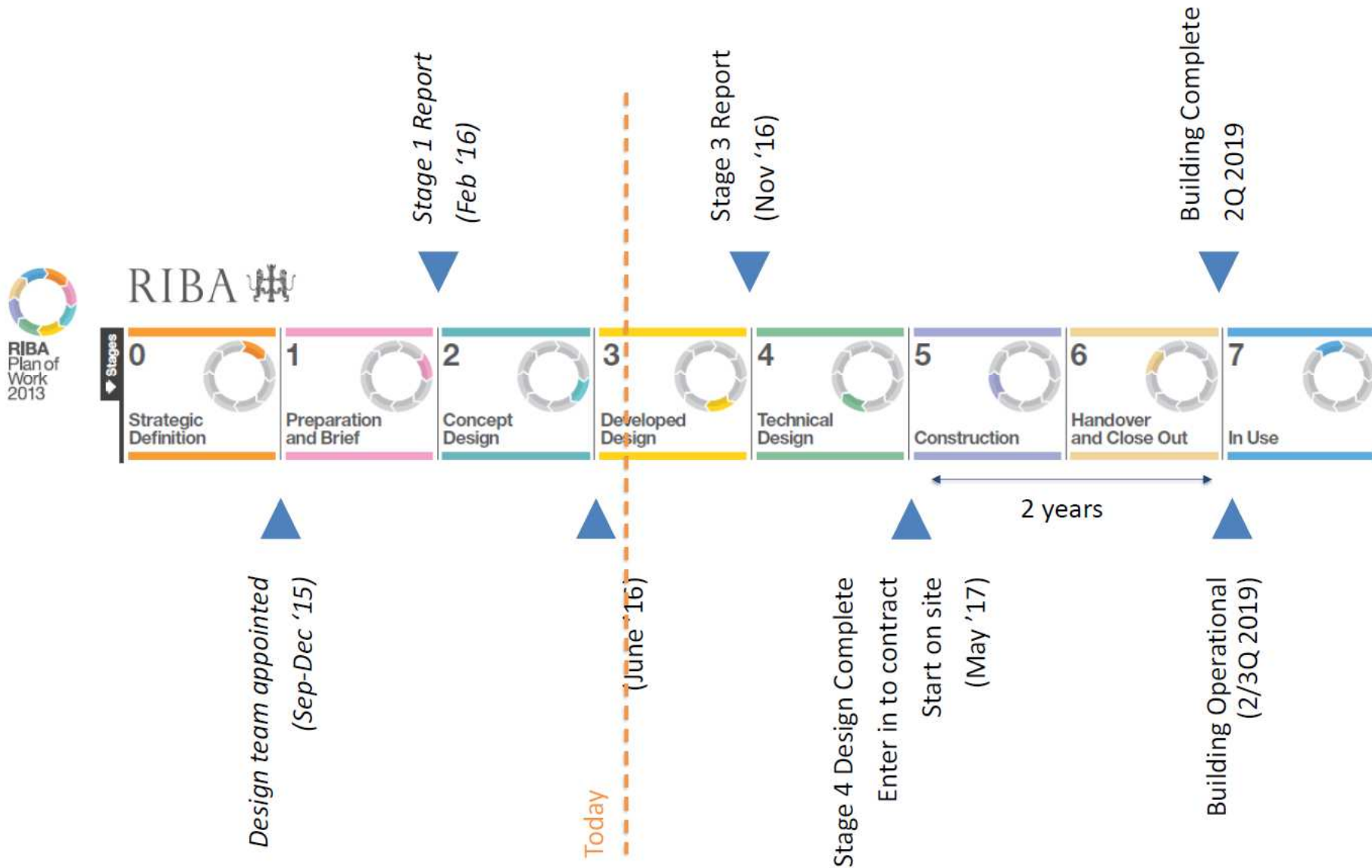
- Builds on UK strengths & Gov investment incl. NNUF & NFCE
- World leading scientific capability
- Supports UK nuclear ambitions
- Underpinned by National & International Collaboration
- Skills pipeline



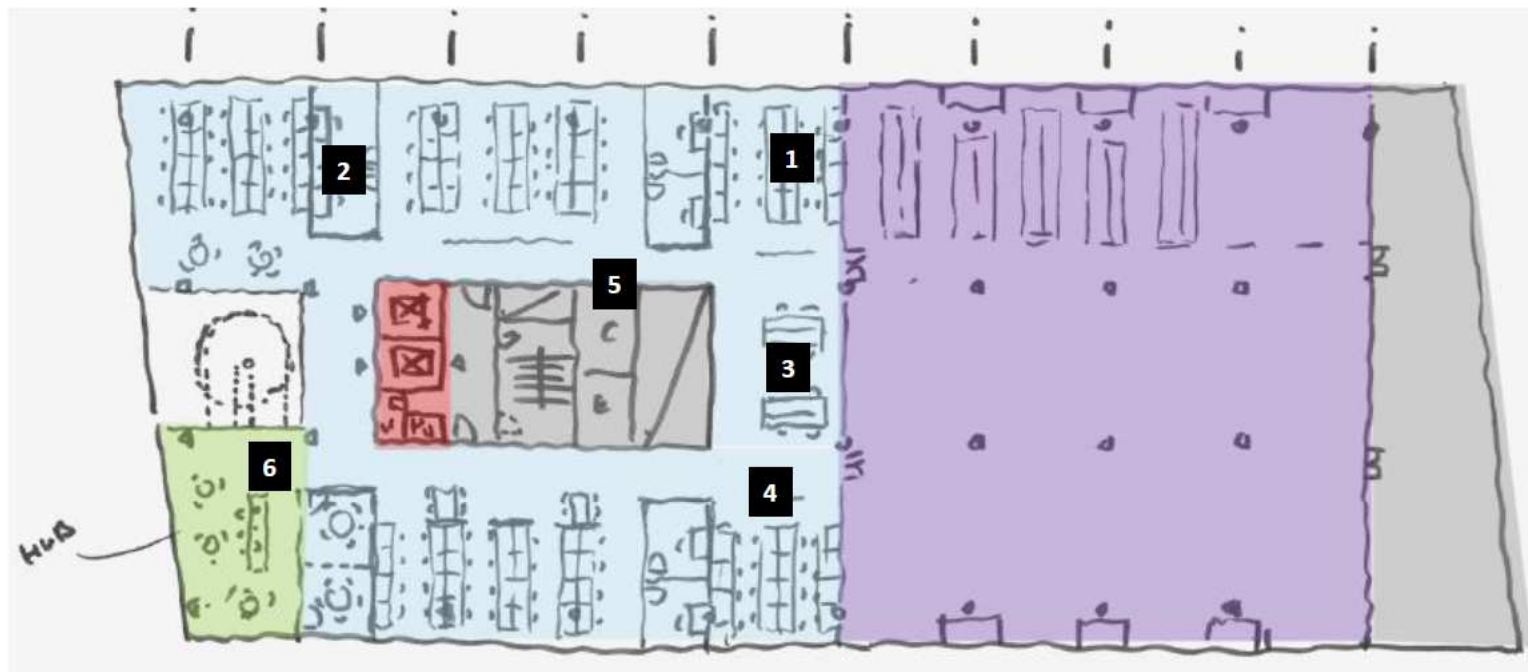
Capital investments

- Manchester –3.5 Mio£ (+ NFCE & Graphite Labs)
- NNL – 6 Mio£
- Oxford – new building investments
- Imperial – new building investments
- Culham – 5 Mio£
- Sheffield – 2Mio£ + new building investments

Hub building: project progress



Hub building: work space options



DRAFT CONCEPT



1. OPEN OFFICE



2. OFFICE-PRIVATE



3. COLLABORATION



4. COLLABORATION BENCH



5. CORRIDOR



6. HUB LOUNGE/TEA POINT

WORK IN PROGRESS – NOT FINAL DESIGN

8 Plant

7 Nuclear

6 Expansion/ Industry Space

5 Chemical Materials/2D Nano

4 Bio Materials/2D Nano

3 MD/FC/Assembly/Bio Materials

2 Expansion Space

1 M4DE

G Heavy Duty AMP

Core

Core

B

Characterisation

Office adjacency optimised

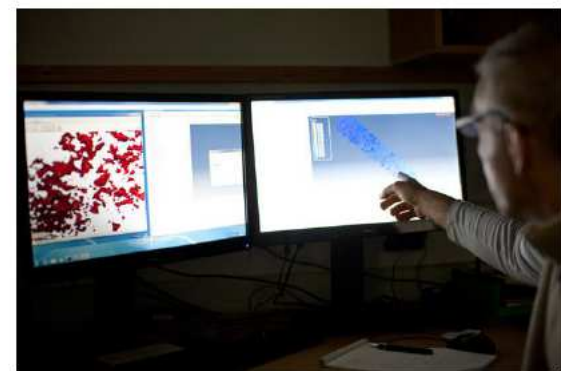
Includes nuclear se with a dumb-waiter shuttle complex

- Includes nuclear sector, with a dumb-waiter to shuttle samples between 7th floor and basement

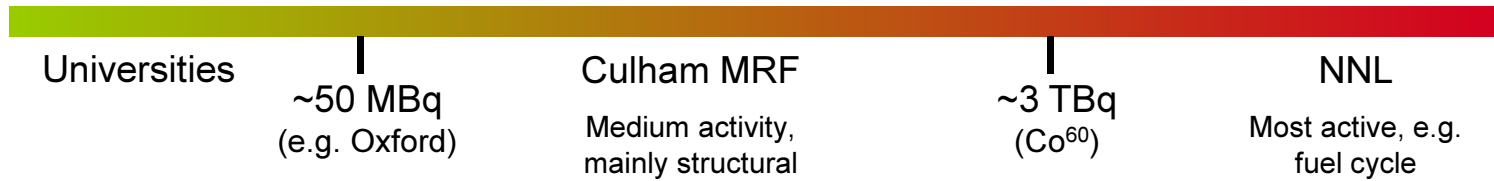
Industrial Engagement with Royce

- The Royce Institute is 'open for business' and we welcome enquiries
- **A flexible, multi-level approach to industrial partnerships:**
 - **Strategic investment partner** (*e.g. laboratory presence within the Royce Hub; co-develop a new research theme*)
 - **Collaborative R&D** (*fully funded or partial grant funding*)
 - **Access model to use equipment**
 - **Visiting researchers/ secondments**

www.royce.ac.uk



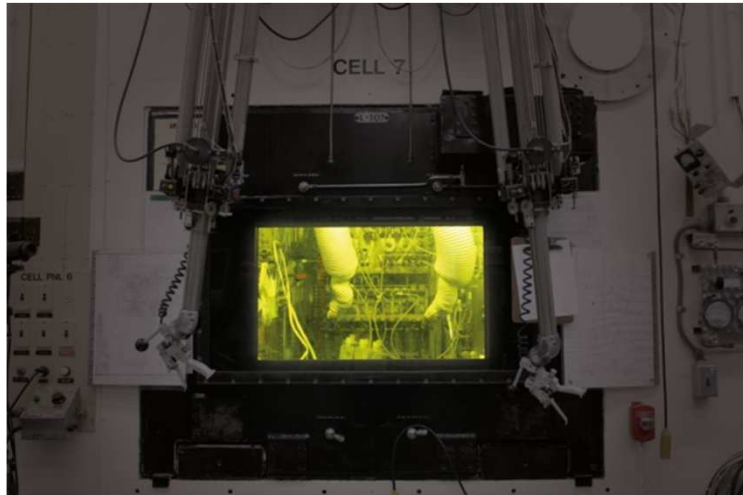
Royce investments in Materials Research Facility at Culham



- New building opens this month. Hot cell processing of radioactive samples on a non-licensed site - for analysis on-site or back at the university
- Fits Royce Nuclear Energy vision:
 - Examining in-service and archive samples, and new materials → improved understanding of radiation damage for life-time extension decisions, and better materials for higher performance in harsher environments (radiation resistance, higher temperature)
 - Link in innovation chain: trace active tests → high active tests (CCFE and NNL providing the high active capabilities, lower activities involve wider range of facilities including universities)
 - Major features: industry involvement, international collaboration, materials modelling, training researchers
- Initially MRF has FIB, SEM, nanoindenter, TDS. **User workshop in July identified priorities for investment - £5M investment programme from Royce envisaged over 3 years**
 - **mechanical**: various length-scales and temperatures – e.g. tensile/compression load frames, fatigue testing, EDM
 - **thermo-physical**: gas pycnometer, laser flash, dilatometer, DSC/TGA
 - bigger range of **active machining/preparation** – electro-polishing, etc.
- First £1M of Royce equipment should be operational by end of 2016/17

Materials Characterisation

-From Sv/h to $\mu\text{Sv/h}$



2016/17

In Cell:
Raman and
Microhardness
Metallurgical
Microscope.
LIBS

Sub-sampling:
Shielded sample
store

Active Labs:
EELS for FEGTEM

Future Proposals

Laser Flash Analyser

Various sample
preparation
(electropolish, ion beam
polish, plasma/UV
cleaner)

SEM Heating Stage
Compression/heating
stage for XRT



The
University
Of
Sheffield.

Department
Of
Materials Science &
Engineering

NucleUS
Immobilisation Science Laboratory

Research strategy for SHRI

- Invest primarily in our strength in metals processing, support nationally important capability in functional, nuclear materials.
- In nuclear theme, primary focus on strength in radwaste management and disposal; fission / fusion core materials driven through metals processing
- Strong engagement: NNL, Sellafield Ltd, RWM, NDA, Hitachi.

Indicative budget

- * £30M SHRI
- * £6M(+?) UoS
- * £4M ESIF (live proposal)

Capital Estate Plans: Centre for Materials Processing

- New research discovery facility on city campus, >2000m² (2-3 years?)
- New research translation facility on AMP campus, 1000m² (next year!)

UoS contribution in SHRI nuclear theme

- Build on £3M UoS / DECC investment in MIDAS facility
- Aspire to mg quantities of Pu-242, Np-237 tracers
- ICP-Mass Spectrometer plus ancillary equipment*
- Inert, negative pressure glove boxes*
- Inert, negative pressure glove box with furnace*
- Radiological protection equipment*
- Vertical scanning interferometer
- High pressure Raman cell*
- High performance stereomicroscope*
- Thermodynamic modelling software
- Large scale cement rheometer
- ...all equipment will handle active materials
- ...not an exhaustive list, maintain flexibility wrt partners

Relevant UoS equipment in other themes

- Arc and vacuum melters
- Large volume hot isostatic press
- Spark plasma sintering
- Atomiser for ALM
- Additive layer 3D printers
- Electro-discharge arc machining
- 5-axis milling machine
- SEM-Raman
- TEM
- ...this is not an exhaustive list!
- ...may not be active capable

Contact: Neil Hyatt
n.c.hyatt@sheffield.ac.uk

THE 1ST STUDENT
EXPERIENCE
SURVEY 2014-15

* Quick wins that could be done this FY.